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Assessment of outcome in patients undergoing surgery for intradural spinal tumor using the multidimensional patient-rated Core Outcome Measures Index and the modified McCormick Scale

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Abstract: **OBJECT** The aim of this study was to evaluate outcome in patients undergoing surgical treatment for intradural spinal tumor using a patient-oriented, self-rated, outcome instrument and a physician-based disease-specific instrument. **METHODS** Prospectively collected data from 63 patients with intradural spinal tumor were analyzed in relation to scores on the multidimensional patient-rated Core Outcome Measures Index (COMI) and the physician-rated modified McCormick Scale, before and at 3 and 12 months after surgery. **RESULTS** There was no statistically significant difference between the scores on the modified McCormick Scale preoperatively and at the 3-month follow-up, though there was a trend for improvement ($p = 0.073$); however, comparisons between the scores determined preoperatively and at the 12-month follow-up, as well as 3- versus 12-month follow-ups, showed a statistically significant improvement in each case ($p < 0.004$). The COMI scores for axial pain, peripheral pain, and back-related function showed a significant reduction ($p < 0.001$) from before surgery to 3 months after surgery, and thereafter showed no further change ($p > 0.05$) up to 12 months postoperatively. In contrast, the overall COMI score, "worst pain," quality of life, and social disability not only showed a significant reduction from before surgery to 3 months after surgery ($p < 0.001$), but also a further significant reduction up to 12 months postoperatively ($p < 0.001$). The scores for work disability showed no significant improvement from before surgery to the 3-month follow-up ($p > 0.05$), but did show a significant improvement ($p = 0.011$) from 3 months to 12 months after surgery. At the 3- and 12-month follow-ups, 85.2% and 83.9% of patients, respectively, declared that the surgical procedure had helped/helped a lot; 95.1% and 95.2%, respectively, declared that they were satisfied/very satisfied with their care. **CONCLUSIONS** COMI is a feasible tool to use in the evaluation of baseline symptoms and outcome in patients undergoing surgery for intradural spinal tumor. COMI was able to detect changes in outcome at 3 months after surgery (before changes were apparent on the modified McCormick Scale) and on later postoperative follow-up. The COMI subdomains are valuable for monitoring the patient's reintegration into society and the work environment. The addition of an item that specifically covers neurological deficits may further increase the value of COMI in patients with spinal tumors.

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Assessment of outcome in patients undergoing surgery for intradural spinal tumor using the multidimensional patient-rated Core Outcome Measures Index and the modified McCormick Scale

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OBJECT The aim of this study was to evaluate outcome in patients undergoing surgical treatment for intradural spinal tumor using a patient-oriented, self-rated, outcome instrument and a physician-based disease-specific instrument.

METHODS Prospectively collected data from 63 patients with intradural spinal tumor were analyzed in relation to scores on the multidimensional patient-rated Core Outcome Measures Index (COMI) and the physician-rated modified McCormick Scale, before and at 3 and 12 months after surgery.

RESULTS There was no statistically significant difference between the scores on the modified McCormick Scale preoperatively and at the 3-month follow-up, though there was a trend for improvement ($p = 0.073$); however, comparisons between the scores determined preoperatively and at the 12-month follow-up, as well as 3- versus 12-month follow-ups, showed a statistically significant improvement in each case ($p < 0.004$). The COMI scores for axial pain, peripheral pain, and back-related function showed a significant reduction ($p < 0.001$) from before surgery to 3 months after surgery, and thereafter showed no further change ($p > 0.05$) up to 12 months postoperatively. In contrast, the overall COMI score, "worst pain," quality of life, and social disability not only showed a significant reduction from before surgery to 3 months after surgery ($p < 0.001$), but also a further significant reduction up to 12 months postoperatively ($p < 0.001$). The scores for work disability showed no significant improvement from before surgery to the 3-month follow-up ($p > 0.05$), but did show a significant improvement ($p = 0.011$) from 3 months to 12 months after surgery. At the 3- and 12-month follow-ups, 85.2% and 83.9% of patients, respectively, declared that the surgical procedure had helped/helped a lot; 95.1% and 95.2%, respectively, declared that they were satisfied/very satisfied with their care.

CONCLUSIONS COMI is a feasible tool to use in the evaluation of baseline symptoms and outcome in patients undergoing surgery for intradural spinal tumor. COMI was able to detect changes in outcome at 3 months after surgery (before changes were apparent on the modified McCormick Scale) and on later postoperative follow-up. The COMI subdomains are valuable for monitoring the patient's reintegration into society and the work environment. The addition of an item that specifically covers neurological deficits may further increase the value of COMI in patients with spinal tumors.

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KEY WORDS spine; intradural; COMI; outcome; McCormick Scale; surgery; Core Outcome Measures Index

INTRADURAL spinal tumors occur with an annual incidence of approximately 2–4 tumors per 100,000 persons and manifest with neurological deficit or nocturnal pain.^{1,2,7} Intradural spinal tumors can be classified as intramedullary (approximately 20% of the cases) or extramedullary, with the majority of the latter being schwannomas and meningiomas.^{1,4} To obtain a histopathological

diagnosis and decompress the neural structures, the treatment of choice is microsurgical resection.^{8,18,20,22}

For patients with intradural spinal tumor, the modified McCormick Scale¹³ is considered the standard outcome tool. It is completed by the treating physician and assesses global functional impairment in terms of neurological function and walking ability. Over the last 2 decades, there

ABBREVIATION COMI = Core Outcome Measures Index.

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has been increasing emphasis on the use of patient-rated outcome measures for assessing the outcome of spine surgery. However, most of the focus has been on degenerative spine surgery, using outcome instruments that address pain, function, and quality of life such as the Oswestry Disability Index, Neck Disability Index, 12-item Short-Form Health Survey, and EuroQol-5 dimensions.^{9,11,14} Patient-rated outcome scales are rarely used to measure the outcome of spinal tumor surgery.^{6,15,16} However, it is important to assess the outcome from the patient's perspective in order to gauge the influence of the disorder on the patient's quality of life and ability to function in everyday life and work, especially as many of these diseases affect patients in the 4th and 5th decades of life.^{2,19} The multidimensional Core Outcome Measures Index (COMI)¹² is a very brief, patient-rated outcome instrument that measures pain, function, symptom-specific well-being, quality of life, and work/social disability associated with disorders of the spine, but without being specific to any one spinal condition. Despite its more "generic" nature, it has proven to be as valid and responsive as disease-specific instruments, such as the Swiss Spinal Stenosis questionnaire¹⁰ and the Scoliosis Research Society-22 questionnaire¹² when used to assess outcomes for their respective spinal disorders.

Therefore, the aim of this prospective outcome study was to analyze the usefulness of COMI as an outcome instrument in patients undergoing surgery for intradural spinal tumor and compare its performance with the widely used modified McCormick Scale.

Methods

Patients

The study was a retrospective analysis of prospectively collected data from 87 consecutive patients who had undergone surgical procedures for intradural spinal tumor between March 2006 and February 2013. The data were registered in a local database administered within the framework of the Spine Tango registry of Eurospine, The Spine Society of Europe.¹⁷ The patients' preoperative symptoms, tumor characteristics, and surgical procedures were all documented in detail. The patients completed questionnaires before surgery and at the 3- and 12-month follow-up, and the surgeon-rated outcomes were evaluated at the same time points. Overall, there was a complete set of pre- and postoperative data for 63 patients, and these patients compose the group included in the present study (Table 1).

There were 31 male (49.2%) and 32 female (50.8%) patients with a mean age of 54.8 ± 17.5 years. Seven patients (11.1%) had a history of previous spine surgery: 5 had undergone spinal tumor surgery, and 2 had undergone single-segment stabilization and fusion for degenerative spine disease.

Surgery and Intraoperative Multimodal Neuromonitoring

Patients were seen in the outpatient department and underwent clinical, neurological, electrophysiological, and neuroradiological examination before surgery. Surgery was performed under general anesthesia using a lamino-

plasty approach in the prone position with multimodal intraoperative monitoring, as previously described.^{2,21} Patients were transferred to the ward 24 hours after surgery. Mobilization under physiotherapeutic observation started 1–2 days after surgery.

Clinical Follow-Up and Outcome Scores

The clinical symptoms, surgical characteristics, complications, and outcome were evaluated from both the surgeon's and the patient's perspectives and documented using the standardized forms accompanying the Spine Tango data acquisition system.¹⁷

The "Spine Tango Surgery Form" was completed by the surgeon and allowed documentation of the main pathology, additional pathologies, previous treatment(s), patient comorbidity status as assessed by the American Society of Anesthesiologists physical status score, surgical procedure, number of affected levels, and both general and surgical complications.

Preoperatively and 3 and 12 months postoperatively, patients completed the multidimensional COMI.¹¹ The questionnaire was sent to the patients by mail to be completed at home. COMI (Scores 0–10) consists of single items that cover the domains of pain (1 question each for axial pain and peripheral pain), function, symptom-specific well-being, general quality of life, and social and work disability. In addition to COMI, at the 3- and 12-month follow-ups, global treatment outcome was assessed with a question inquiring how much the operation had helped the back/neck problem overall (5 response categories: 1 = helped a lot; 2 = helped; 3 = helped only little; 4 = did not help; and 5 = made things worse). Patient-rated satisfaction with care was also rated using a 5-point Likert scale. (Patients were asked: "Over the course of treatment for your back/neck problem, how satisfied were you with the medical care in our hospital?") Response categories included the following: 1 = very satisfied; 2 = somewhat satisfied; 3 = neither satisfied nor dissatisfied; 4 = somewhat dissatisfied; and 5 = very dissatisfied.

The surgeon rated the patient's global functional impairment during clinical examination in the outpatient clinic using the modified McCormick Scale. The score categories were: 1 = neurologically intact; 2 = mild motor or sensory deficit, but functional independence; 3 = moderate deficit and limitation of function; 4 = severe motor or sensory deficit, dependent; and 5 = paraplegia or quadriplegia.

Imaging

Preoperative MRI was performed using different MRI scanners of at least 1.5 T. Postoperative imaging was performed using a Philips Achieva 3 Tesla MRI scanner. Imaging was analyzed independently by radiologists, who were blinded to the clinical outcome using standardized software (picture archiving and communication system [PACS]), in order to define the degree of resection of the intradural spinal tumors.

Statistical Analysis

The significance of the differences in continuous, normally distributed data was analyzed using paired Student

TABLE 1. Patient demographics and characteristics

Variable	Value*
No. of patients	87
No. of patients in the study group	63
Male/female	31 (49.2)/32 (50.8)
Mean age in yrs	54.8 ± 17.5
Localization of intradural tumor	
Cervical spine	20 (31.7)
Thoracic spine	17 (26.9)
Lumbar spine	26 (41.3)
Histopathological diagnosis	
Meningioma (WHO Grade I/II)	23 (36.5) (22 WHO I, 1 WHO II)
Neuroma (WHO Grade I)	15 (23.8)
Ependymoma (WHO Grade I/II)	13 (20.6%), (9 WHO I, 4 WHO II)
Astrocytoma (WHO Grade II)	2 (3.2)
Other	10 (15.9)
Mean no. of affected/operated segments†	1.23 ± 0.64 (1–5)
Duration of hospitalization in days	9.13 ± 2.65
Extent of tumor resection	
Gross-total resection (>98%)	46 (73.0)
Subtotal resection (>90%)	14 (22.2)
Biopsy	3 (4.8)

* Values represent the number of patients (%) unless stated otherwise. Mean values are presented as the mean ± SD.

† The mean ± SD (range) is shown here.

t-tests. Data from the pre- and postoperative COMI subscales and the McCormick score were analyzed using the nonparametric Wilcoxon signed rank test. Continuous data are presented as the mean ± SD, and statistical significance was accepted at the $p < 0.05$ level.

The statistical analyses were performed using Microsoft Excel (version 2011, Microsoft Corp.) and SPSS software (version 22.0, IBM).

Results

Surgical Procedures, Tumor Characteristics, and Pathology

The demographic and clinical characteristics of the 63 patients, including the location of the tumors and the results of the neurohistopathological workup, are shown in detail in Table 1. In all patients, gross-total resection was aimed for and this was achieved in 46 of 63 (73%) patients. In 3 patients, tumor removal was stopped after deterioration of the multimodal intraoperative monitoring parameters at the stage of an extended biopsy.

Outcome Measures: Modified McCormick Scale

The distributions of the scores on the modified McCormick Scale before surgery and at 3- and 12-month follow-ups are shown in Table 2. There was no statistically significant difference between scores before surgery and at the 3-month follow-up, though there was a trend ($p = 0.073$) toward improvement. Comparison of the scores obtained preoperatively and at the 12-month follow-up, as well as at 3-month versus 12-month follow-ups, showed

statistically significant improvements ($p = 0.004$ and $p = 0.002$, respectively).

Outcome Measures: COMI and COMI Subdomains

The changes in the COMI and COMI subdomain scores are shown in Table 3 and Fig. 1.

The scores for axial pain, peripheral pain, and back-related function showed a significant reduction ($p < 0.001$) from before surgery to 3 months after surgery, and thereafter showed no further change ($p > 0.05$) up to 12 months postoperatively. In contrast, the overall COMI score, “worst pain” (the higher of the 2 pain scores, either axial or peripheral), quality of life, and social disability not only showed a significant ($p < 0.001$) reduction from before surgery to 3 months after surgery, but also a further significant reduction up to 12 months postoperatively ($p < 0.05$) (Fig. 2). Work disability showed no significant improvement from before surgery to the 3-month follow-up ($p >$

TABLE 2. Modified McCormick Scale scores at preoperation and 12 months postoperation

		Modified McCormick Scale Score 12 Mos Postop			
		1	2	3	4
McCormick Scale score before surgery	1	16	2	1	1
	2	8	5	0	0
	3	4	5	1	0
	4	4	0	0	0

TABLE 3. COMI scores at obtained preoperatively and 3 and 12 months postoperatively

Variable	Preop		3 Mos Postop		12 Mos Postop	
	Mean	SD	Mean	SD	Mean	SD
COMI overall*	6.0	2.3	3.4	2.5	2.6	2.3
COMI back/neck pain*	4.2	3.0	2.3	2.5	2.1	2.3
COMI radicular pain*	4.8	2.9	2.3	2.5	2.0	2.2
COMI highest pain*	5.8	2.5	3.0	2.6	2.6	2.4

* Score 0–10.

0.05), but did show a significant improvement between the 3-month and 12-month follow-ups ($p = 0.011$) (Fig. 3).

Outcome Measures: Global Treatment Outcome and Satisfaction with Care

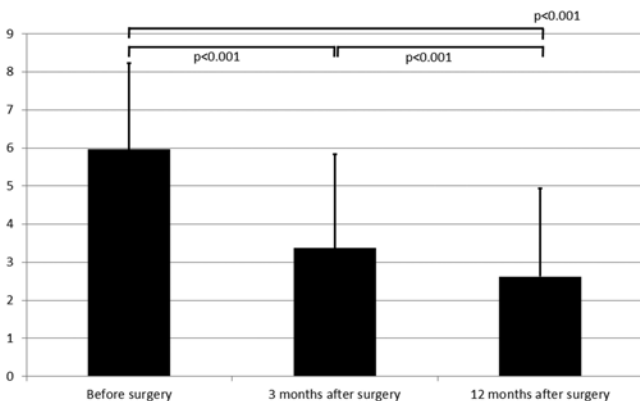
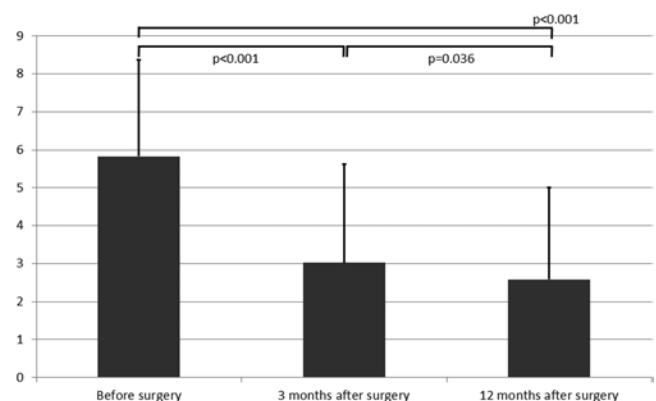
The ratings of global treatment outcome and satisfaction with care at the 3-month and 12-month follow-ups are shown in Table 4. At the 3-month follow-up, 85.2% of patients declared that the surgical procedure had either helped or helped a lot, and at the 12-month follow-up the proportion was 83.9%. At the 3-month follow-up, 95.1% of patients were either satisfied or very satisfied with their care, and at the 12-month follow-up the proportion was 95.2%.

Discussion

In the present study, we analyzed the outcomes of patients who had been surgically treated for intradural spinal tumors using the scores on both the patient-rated multidimensional COMI and the widely used physician-rated modified McCormick Scale. We found that both instruments indicated a statistically significant improvement at 12 months after surgery, but only COMI showed a significant improvement 3 months postoperatively. Interestingly, both scores showed a statistically significant clinical improvement between 3 months and 12 months after surgery, indicating the importance of monitoring the clinical outcome and postoperative course of spinal tumor patients for more than 3 months and the potential for clinical improvement over a longer postoperative period.

There is ongoing discussion in the literature regarding the optimal evaluation of outcome in patients undergo-

ing surgery for intradural spinal tumor. Current reports include the perspectives of both the surgeon and the patient.^{3,6,8} In comparison with outcome studies on degenerative spinal disorders, for which many different outcome scales have been introduced and validated in the last decade,^{5,9,11} novel and validated outcome scales for spinal tumor patients are still lacking in the literature. Patient-rated outcome scales, which are gaining increasing importance as outcome measures in neurosurgery, are rarely used to monitor outcome in spinal tumor patients. In the only patient-rated outcome study conducted to date, Guirado et al.⁶ showed that the 36-item Short-Form Health Survey was useful for assessing quality of life and outcome in patients undergoing intradural spinal tumor surgery. The authors discussed that the outcome assessed from the patient's perspective provided data on domains that are not addressed by existing disease-specific myelopathy scales. This statement is very important since patients with intradural spinal tumors are mostly in their 4th and 5th decades of life, and one of the treatment goals is to return these patients to their former social and work environments. We showed in the present study that patient-rated outcome can be successfully monitored on a prospective basis using a brief but comprehensive multidimensional instrument that assesses all important domains, including axial and peripheral pain, function, quality of life, days with reduced activity, and days off work (disability). At the 3-month follow-up, 85.2% of the patients stated that the surgery had helped or helped a lot. In our opinion, this indicates that there was a perceptible change in symptoms or burden of disease at the first follow-up compared with the status before surgery. The subdomains of the COMI and the overall COMI score were, hence, more sensitive than

**FIG. 1.** COMI scores (x axis).**FIG. 2.** COMI: highest pain scores.

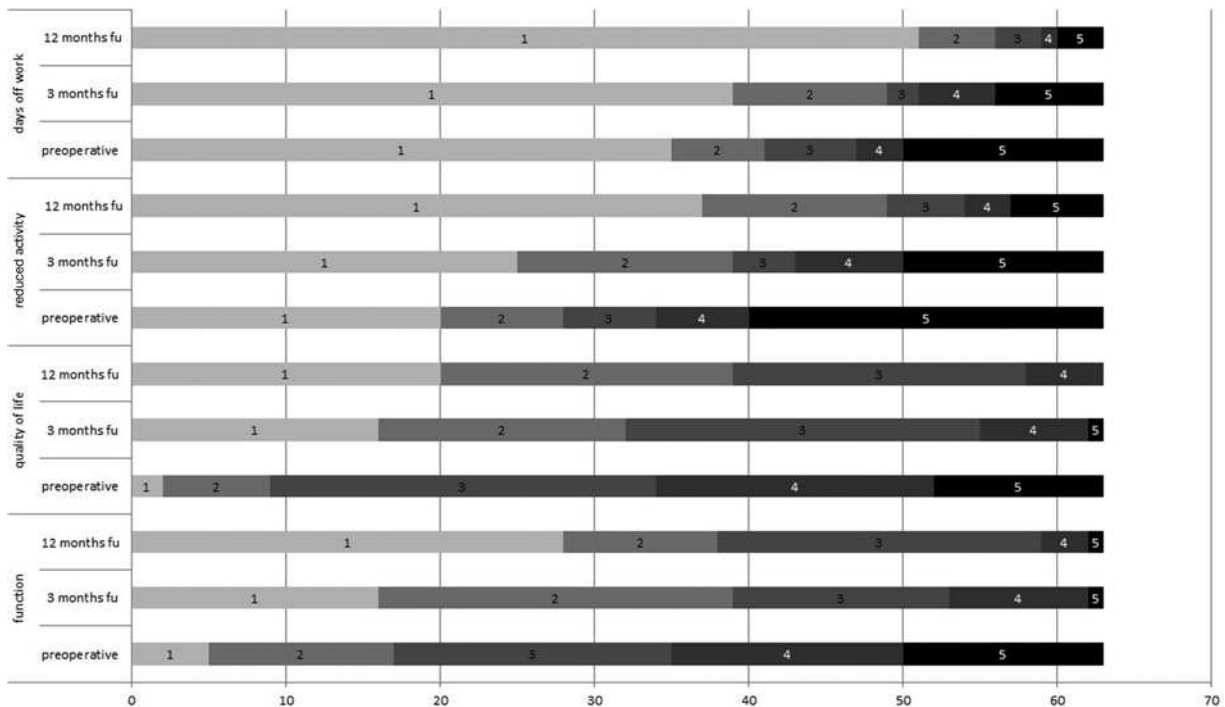


FIG. 3. COMI subscore visualization with the numbers of patients in different categories. fu = follow-up.

the modified McCormick Scale, in that they were able to detect this early improvement that was not detected using the modified McCormick Scale. After 3 months, both the COMI and the modified McCormick Scale showed a similar course of change (further improvements up to the 12-month follow-up).

COMI was originally established to assess outcome in patients with back pain, and it has no specific items for assessing the types of neurological deficit that typically accompany intradural pathologies. COMI is, therefore, more of a patient-rated scale for assessing back/neck function and health-related outcome in general, while the modified McCormick Scale specifically covers functional and neurological details, but from the physician's perspective only. Many of COMI's items (e.g., function, symptom-specific well-being, quality of life) indirectly assess the consequences for the patient of having such neurological deficits; nonetheless, in further studies, it would be interesting to consider the value of developing an additional item for COMI that specifically quantifies the neurological status from the patient-rated point of view.

The question remains as to which is of greater importance: the back/neck health-related outcome as measured by the patient-rated COMI, or the neurological outcome as measured by the physician-based modified McCormick Scale. We believe that both instruments are probably required to provide a comprehensive assessment of outcome in relation to intradural spinal tumor surgery. The modified McCormick Scale provides an evaluation of the so-called "objective" consequences of the tumor, but the patient-rated COMI data provides important information regarding the impact of these objective findings on the patient's quality of life and ability to function in everyday life and work. We, therefore, believe that the information

provided by COMI represents an essential part of the outcome assessment for intradural spinal tumor surgery.

Conclusions

COMI is a feasible tool to use in the evaluation of baseline symptoms and outcome in patients undergoing surgery for intradural spinal tumor. COMI was able to detect changes in outcome at 3 months after surgery (before changes were apparent on the modified McCormick Scale) and during further postoperative follow-up. The COMI subdomains are valuable for monitoring the patient's reintegration into society and the work environment. The addition of an item that specifically covers neurological

TABLE 4. Patient-rated global treatment outcome and overall satisfaction with care

Score	Number of Patients	
	3 Mos Postop	12 Mos Postop
Global treatment outcome		
1	33	44
2	19	8
3	5	9
4	4	1
5	0	0
Satisfaction w/ care		
1	53	54
2	5	5
3	2	1
4	1	0
5	0	0

deficits may further increase the value of COMI for patients with spinal tumors.

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Author Contributions

Conception and design: Bellut, Burkhardt. Acquisition of data: Bellut, Burkhardt. Analysis and interpretation of data: Bellut, Burkhardt, Mannion. Drafting the article: Bellut, Burkhardt, Mannion. Critically revising the article: Porchet, Mannion. Reviewed submitted version of manuscript: Mannion. Statistical analysis: Bellut, Burkhardt, Mannion. Study supervision: Porchet, Mannion.

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